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ABSTRACT

This workbook, designed for workplace literacy courses, contains materials for a mathematics review course to be taken prior to a course in blueprint reading. The course provides practice in the mathematics skills students need in order to take a blueprints course, including practice in calculating decimals, linear measurement, common fractions and mixed numbers, and determining angles. Introductory materials include objectives, a topical outline, a course outline, and information on course time. The workbook contains teacher tips for 10 sessions (handouts and materials, lecture ideas, and classroom exercises), information sheets and problem set materials for four sessions, and a pretest and a posttest with answers. The lessons and units include information sheets and problems to solve through mathematics and measurement. (KC)

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Pre-blueprint Math

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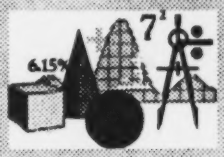
Pre-blueprint Math



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1994

ACKNOWLEDGMENT

Mercer County Community College thanks Jean Meier, Senior Education Specialist/Curriculum Developer and Linda Lam, Basic Skills Instructor for creating this manual. Through their valuable contributions employees in manufacturing and service industries learned concepts relevant to their existing jobs and strategies for learning other tasks if that opportunity should arise.

TEACHER TIPS

TEACHER TIPS ◆ SESSION 1

- **Student introductions**

- **Course overview**

- **Pre-test**

- **Handouts/Materials**
  Course outline
  Unit 1: Decimal Fractions (Page 1 only.)

- **Lecture/Discussion:**
  Explain the meaning and use of decimals. Emphasize the place value chart.
  Discuss the following topics. Encourage students to give reasons for their answers in their own words.

  ◊ Which is larger .1 or .01?
  ◊ Which is larger .6 or .60?
  ◊ Which is larger .5 or .09?
  ◊ What is half of .1?
  ◊ Write 65 thousandths.
  ◊ Which is the largest?
    * 7 tenths
    * 70 hundredths
    * 700 thousandths

TEACHER TIPS ◆ SESSION 2

- **Handouts/Materials**
  Unit 1: Decimal Fractions (page 2–4)
  Conversion Table
  Problem Set – Unit 1 (problems # 1–#20)

- **Lecture**
  Emphasize rounding, and adding/subtracting decimals.

  Use the conversion chart as well as the calculator to convert from fractions to decimals.

  Multiplication and division of decimals will usually be done on a calculator but long hand methods should be covered as well.

- **Classroom Exercises**
  Have students work in pairs or small groups to complete problems #1–20.

- **Discussion**
  After working on the problem set, ask the following questions:
  - ◊ What is the difference between linear feet and square feet?
  - ◊ How many minutes is 3.25 hours?
  - ◊ What does the symbol ø mean?
  - ◊ Where is the diameter of a bolt?
  - ◊ What does ft./min. mean?

TEACHER TIPS ◆ SESSION 3

- **Handouts/Materials**
  Unit 1: Decimal Fractions (Page 5–7)
  Problem Set – Unit 1 (problems # 21–31)

- **Lecture**
  Explain that dimensions on blueprints should be used as is without any calculations. When measuring pieces, however, it is often convenient to measure certain dimensions and add or subtract to find others.

  Discuss tolerance and emphasize the different ways it may be written. NOTE: $\frac{2.625}{2.375}$ does not indicate division but rather upper and lower limits.

  Explain that circles on blueprints usually indicate holes. On a blueprint the diameter of the hole will be given, but spacing between holes is indicated from center to center.

- **Classroom Exercise**
  Work in pairs or small groups on problems # 21–31

- **Discussion**
  Help students understand how arrows are used on blueprints. (See, for instance, problem # 23)

  Mention the use of TYP to mean typical or the same in several places.

  Discuss problem #31 in detail. It is preparation for future exercises where students will do the measurements themselves.

TEACHER TIPS ◆ SESSION 4

- **Handouts/Materials**
  Unit 2: Linear Measurement
  Problem Set – Unit 2 (page 1,2 only)
  Blueprint of part # 21A308981 (Control Box Cover) with all dimensions blanked out
  Enough control box covers for each pair of students.
  Decimal inch rulers

- **Lecture**
  Explain how to read a measurement on a decimal ruler. Emphasize the equivalence of two hundredths and one fiftieth.

- **Classroom Exercise**
  Complete problems # 1–7 on Unit 2 Problem Set.

  After checking student answers on the problem set, give each student a copy of the blueprint and each pair of students a control box cover. Have them fill in the missing dimensions on the top and front view.

- **Discussion**
  Discuss the limitations of a steel rule.

  ◊ Were measurements of the diameter of the hole accurate?
  ◊ Were students able to accurately measure from the edge to the center of the hole? Discuss alternate ways of making this measurement, e.g. measure from the edge of the piece to the edge of the hole and then add on half the diameter.

  Explain how to measure the notch on the left side view. It consists of a rectangle and half a circle.

TEACHER TIPS ◆ SESSION 5

- **Handouts/Materials**
  Unit 2: Linear Measurement
  Problem Set – Unit 2 (page 1, 2 only)
  Blueprint of part # 21A308981 (Control Box Cover) with all dimensions written in
  Enough control box covers for each pair of students.
  Decimal inch rulers
  Dial Calipers

- **Lecture**
  Explain how to read a measurement on a dial caliper.

  Demonstrate how to use the three different parts of the caliper to make the following three types of measurements: outside measurements (length) inside measurements (diameter of a hole) depth

- **Classroom Exercise**
  Complete problems # 4–6 on Unit 2 Problem Set using the caliper

  After checking student answers on the problem set, give each students a control box cover. Have them complete filling in all missing dimensions on their drawing from session # 4.

  When students have completed their measurements, hand out the original blueprint with upper and lower limits given. Have students determine if their piece is within the tolerance limits.

- **Discussion**
  Discuss the advantages of using the caliper versus the steel rule.

  Discuss which part of the caliper will give the most accurate measurement for given situations.

TEACHER TIPS ◆ SESSION 6

- **Handouts/Materials**
  Unit 2: Linear Measurement
  Problem Set – Unit 2 (page 3)
  Any parts for which the corresponding blueprint is available (a different part for each pair of students)
  Micrometers
  Calipers
  Rulers

- **Lecture**
  Explain how to read a measurement on a Micrometer.

  Explain how to convert between different English units of measurement.

- **Classroom Exercise**
  Complete problems # 8, 9 on Unit 2 Problem Set.

  After checking student answers on the problem set, give each pair of students a part. Have them accurately draw a front view of their part. Make as many measurements as possible with the micrometer.

  When the drawing is complete give them the corresponding blueprint and have them determine if their part is within the tolerance limits.

- **Discussion**
  Discuss when the use of a micrometer is appropriate and when it isn't.

  Discuss any differences between the dimensions students chose to measure and those shown on the blueprint.

  Have each pair share their drawing with the whole group. Discuss any questions that arise as to what a front view is. Explain what a side view and a top view would look like.

TEACHER TIPS ◆ SESSION 7

- **Handouts/Materials**
  Unit 3: Common Fractions and Mixed Numbers
  Problem Set – Unit 3 (page 1, 2 only)
  Graph paper (4 squares to the inch)

- **Lecture**
  Lead students through the steps of constructing their own enlarged picture of a ruler. (See directions on the following page)

  Have students answer the following questions by looking at the ruler they have drawn. Then discuss the problems arithmetically.

  Which is larger $\frac{1}{8}$ or $\frac{1}{16}$? $\frac{3}{4}$ or $\frac{13}{16}$?

  ◊ Find three different fractions that have the same value.

  ◊ How many sixteenths are in one whole?

  ◊ Write three fractions that are greater than a whole.

  ◊ Write the same three fractions as mixed numbers.

  ◊ What number is twice as large as $\frac{1}{8}$?

  ◊ What is half of $\frac{1}{32}$?

  ◊ Approximately where would $\frac{3}{128}$ be on the ruler?

  ◊ Approximately where would 4.2 be on the ruler?

  ◊ Does $\frac{1}{8} + \frac{1}{4} = \frac{2}{12}$?

- **Classroom Exercise**
  Complete problems # 1–9 on Unit 3 Problem Set.

TEACHER TIPS ◆ SESSION 8

- **Handouts/Materials**
  Unit 3: Common Fractions and Mixed Numbers
  Problem Set – Unit 3 (Problems #10–34)
  One bolt for each pair of students
  Rulers, micrometers, calipers

- **Lecture**
  Discuss adding/subtracting/multiplying/dividing fractions
  Review converting fractions to decimals

  Discuss threads per inch

  Review tolerance

  Review radius and diameter

- **Classroom Exercise**
  Complete problems #10–34 on Unit 3 Problem Set.

  Give each pair of students a bolt. Using a fractional inch rule, have students measure the dimensions indicated in the drawing in problem # 34. Check measurements with a micrometer or caliper. Have students decide what size wrench would be needed for their bolt. Determine how many threads per inch their bolt has.

TEACHER TIPS ◆ SESSION 9

- **Handouts/Materials**
  Unit 4: Angular measurement
  Problem Set – Unit 4
  Protractor
  Final review (same as pretest)

- **Lecture**
  Discuss angular measurement including:
  - ◊ right angles
  - ◊ complements/supplements
  - ◊ internal and external angles
  - ◊ use of the protractor

- **Classroom Exercise**
  Complete problems #1–10 on Unit 4 Problem Set.

  Complete final review

TEACHER TIPS ◆ SESSION 10

- **Discussion**
  Suggestions for improvements/comments about the class
- **Written evaluations**
- **Posttest**

PRE-BLUEPRINT MATH

COURSE OUTLINE:

In order to read a blueprint accurately it is necessary to know how to calculate angles, convert fractions to decimals, measure accurately, and use the micrometer, 6 inch rule, protractor, and caliper. This hands-on math course gives you practice in the math skills you need before you take the blueprint course.

OBJECTIVES:

Upon completion of this course, students will be able to calculate using the following:

- decimals
- linear measurement
- common fractions and mixed numbers
- anglular measrement

TOPICAL OUTLINE:

- Basic stratagies for calculating decimals and mixed numbers
- Using machinists tools to calculate measurement
- Methods for calculating common fractions and mixed numbers
- Determining angles

OTHER:

- 20 hours
- 10 sessions

PRE-BLUEPRINT MATH ◆ SESSION 1

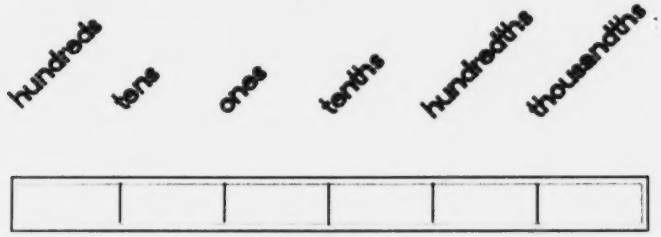
DECIMAL FRACTIONS AND MIXED DECIMALS

A. Basic Skills
- read and write decimal fractions using place value chart
- express decimal fractions as common fractions
- round decimal fractions

It is important to understand decimal fractions because most blueprints are dimensioned with decimal fractions rather than common fractions.

Decimal Fractions

The place value chart gives the value of the digits, with respect to the position from the decimal point.



To read a decimal fraction, read the number as a whole number, then say the name of the place value where the last digit falls.

The following three numbers all have the same value:

0.5 is read as 5 tenths

0.50 is read as 50 hundredths

0.500 is read as 500 thousandths

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BASIC SKILLS

Rounding Decimals

To round a decimal fraction, determine the number of decimal places required,

- if the digit to the right of this decimal place is less that 5, eliminate all the digits following it.
- if the digit to the right of this decimal place is 5 or more, add one to the last required digit and eliminate all the digits following it.

e.g. round 0.368 to 2 places (nearest hundredth)

$0.368 = 0.37$

Express Common Fractions as Decimal Fractions

To express a common fraction as a decimal fraction requires division of the numerator by the denominator.

With repeating decimals, the division should be carried out one more place than the number of places required in the answer, then rounded.

e.g. express $\frac{5}{7}$ as a 2 place decimal

e.g. $\frac{5}{7} = 5 \div 7 = 7\overline{)5.000} = .71$

Express Decimal Fractions as Common Fractions

Read the place value of the last digit.

e.g. $0.357 = \frac{357}{1000}$

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ADDITION/SUBTRACTIONS SKILLS

B. Addition/Subtractions Skills
- add/subtract decimals, mixed decimals and whole numbers
- add/subtract decimal fractions

Adding and subtracting decimal fractions are required at various stages in the production of most products and parts. It is necessary to add and subtract decimals in order to compute tolerances, to determine locations and lengths of cuts, and to inspect finished parts.

Adding and Subtracting Decimal Fractions

To add decimal fractions:

(1) arrange the numbers so that the decimal points are directly under each other,

(2) add, as with sole numbers and

(3) place the decimal point in the answer directly under the other decimal points.

e.g. Add 5 + .02 Subtract 3.07 - .005

5.	3.070
.02	- .005
5.02	3.065

Note: To reduce the possibility of error, place zeros in all place values which have no digits.

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MULTIPLICATION AND DIVISION SKILLS

C. Multiplication and Division Skills
- multiply and divide decimal fractions
- multiply and divide decimals, mixed decimals, and whole numbers

A machinist must readily be able to multiply and divide decimal fractions for computing, for determining lengths, and for solving problem involving geometry.

Multiplying Decimal Fractions

To multiply decimal fractions, multiply using the same procedure as with whole numbers. Place the decimal point in the answer the same number of decimal places as there are in both numbers being multiplied.

e.g.
$$\begin{array}{rl} 50.123 & \text{(3 places)} \\ \times\quad 0.87 & \text{(2 places)} \\ \hline 43.60701 & \text{(5 places)} \end{array}$$

Dividing Decimal Fractions

To divide decimal fractions, (1) move the decimal point of the divisor as many places to the right as are necessary to make the divisor a whole number, (2) move the decimal point in the dividend the same number of places as were moved in the divisor, (3) place the decimal point in the quotient directly above the decimal point in the dividend, (4) add zeros to the dividend if necessary, and (5) divide as with whole numbers. Round as required.

e.g. Divide 0.643 by 0.28. Round to 3 decimal places

$$\begin{array}{r} 2.2964 \\ .28\overline{)0.643000} \end{array} \approx 2.296$$

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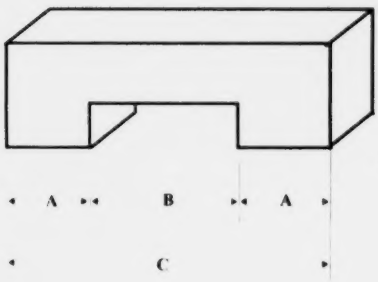
DECIMALS AS DIMENSIONS

D. Decimals as Dimensions

When measuring parts it is often necessary to determine lengths not measured, based on dimensions that are measured.

If dimensions for A and B are known, what is C?



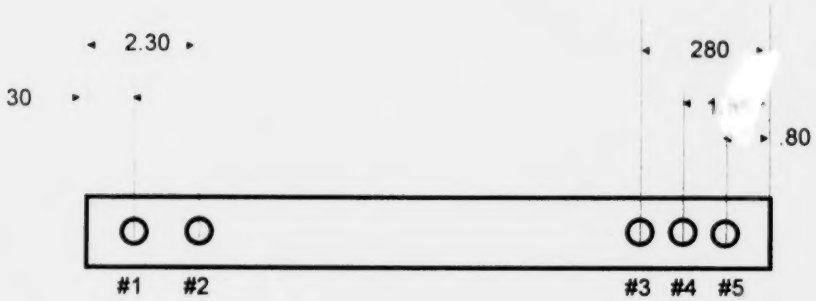
A = ″

B = 2″

C = ?

On a blueprint drawing, however, missing dimensions should not be calculated.

Dimensions should be measured only as shown on the drawing.



For example: In the drawing above, holes #1 and 2 must be measured only from the left edge. Hole #3, 4 and 5 must be measured from the right edge.

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TOLERANCES

E. Tolerances

- compute tolerances based on upper and lower limits of dimension

In industry, the tolerance of a part or component is the acceptable amount that the part or component may vary from a given size.

Definitions

Tolerance is the amount of variation permitted on the dimensions or surfaces of manufactured parts.

A basic dimension is the standard size from which the maximum and minimum limits are determined.

Limits are the extreme permissible dimensions of a part.

The tolerance interval is equal to the difference between the upper and lower limits.

If the tolerance of the length of a piece is 3.5″ ± .125″, then the length of the piece has:

- an upper limit of 3.625 inches.
- a lower limit of 3.375 inches

The tolerance interval is the difference between the upper and lower limit.

$$\begin{array}{r} 3.625 \\ -\ 3.375 \\ \hline .25 \end{array}$$

Tolerances can also be written as follows:

$$\begin{array}{ll} 2.625'' & \text{upper limit} \\ \hline 2.375'' & \text{lower limit} \end{array}$$

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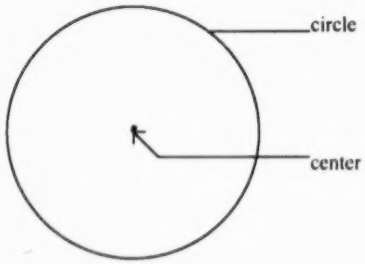
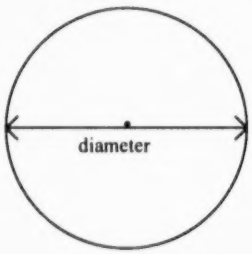
CIRCLES

F. Circles
- Calculating diameter and radius

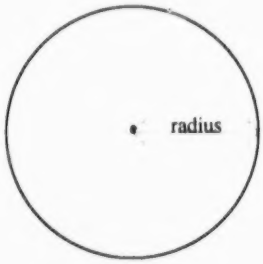
Circles are used repeatedly in drawings. A circle is a plane figure with each point on it an equal distance from a point inside, called the center of the circle.



The diameter of the circle is the distance across the circle through the center.



The radius is the distance from the center of the circle to a point on the circle.



The diameter of a circle is equal to twice the radius.
The radius of a circle is equal to one-half the diameter

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PRE-BLUEPRINT MATH ◆ PROBLEM SET 1

DECIMAL FRACTIONS AND MIXED DECIMALS

1. Express each decimal in words.

   0.004 = _____

   0.021 = _____

   7.1 = _____

2. Express each of the following in decimal form.

   five and two hundredths _____

   sixty-five thousandths _____

   three and four ten-thousandths _____

3. Express each common fraction as a decimal number.

   $\frac{3}{100}$ = _____ $\frac{11}{1000}$ = _____

   $5\frac{9}{10}$ = _____ $\frac{125}{1000}$ = _____

4. Express each decimal fraction as a common fraction.

   0.7 = _____ 0.11 = _____

   0.842 = _____ 14.613 = _____

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5. Round each number in the left column to the place value indicated in each of the other columns.

	tenths	hundredths
5.732		
302.855		
12.0731		
5.897		
4.302		

6. Compare these decimals. Indicate which one is the smallest in each pair.

.001	.0010
.029	.03
.067	.076
.01	.009

7. Add the following.

137.64 + 7 + 0.008 + 6.1 63 + 4.7 + 19.45

8. Subtract the following:

159 - 72.4 4.7 - 3.12 140 - 16.412

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9. Sheets of steel are stacked to a height of 4" on a pallet. The metal sheets are .025" thick. How many are on the pallet?

10. A roll of sheet steel is 144 feet long and 3 feet wide. How many pieces 3 feet long and 2 feet wide can be produced from this roll?

11. A roll of sheet metal stock contains 8240 lin. ft. of strip steel. It is shortened at a rate of 25.5 ft./min. on a production run which lasts 3 hours. How much stock remains on the roll?

12. An automatic lathe produces .4" diameter bolts of various lengths at a rate of 30 per min. It ran for a total of 3.25 hours. How many bolts were produced?

13. A company has an order for 536 sheet metal boxes. Each box uses 27 sq. ft. of 20 gauge. material. How many sq. ft. does it take to fill the order?

14. A bar of steel 3" ∅ (diameter) and 18 feet long weighs 180 lbs. How much would 36 bars weigh?

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15. A shop received 170 packages of sandpaper. Each package contained 25 sheets. If each sheet was cut into 4 parts, how many parts were made?

16. A board is measured to be 6 inches in length. A piece measuring .95 inches is cut from it. How much is left?

17. Multiply the following.

    3.7 x 0.15 14.1 x 1.7

18. Divide the following: Round to the nearest hundredth.

    36 ÷ 1.2 75 ÷ 20.4

19. Determine the following:

    What is half of .001?

    What is half of .05?

20. A pallet is being loaded by an operator with his stampings which weigh 2.4 pounds each. How many can he stack on the pallet if the operator has a weight limit of 600 pounds?

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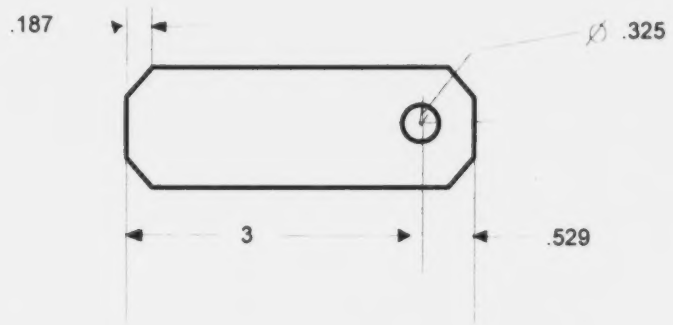
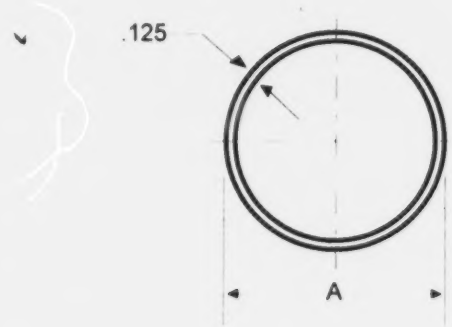
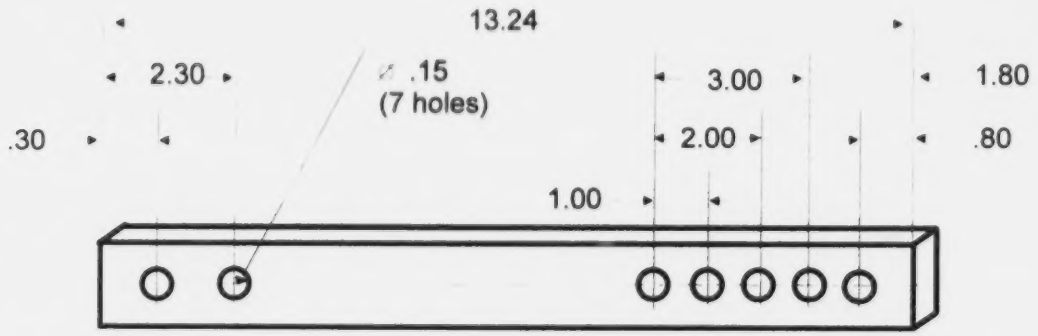
21. What is the overall length of the plate illustrated? (Ø .325 means diameter .325) All measurements are in inches.



22. Find the missing dimension. The inside diameter is 4.023 inches.



23. What is the spacing of the holes from center to center on the left side? on the right side? All measurements are in inches.



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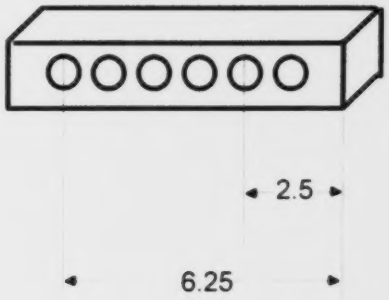
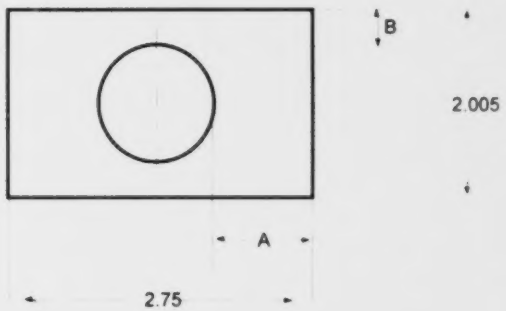
24. What is the spacing of the holes from center to center? (The holes are evenly spaced.)



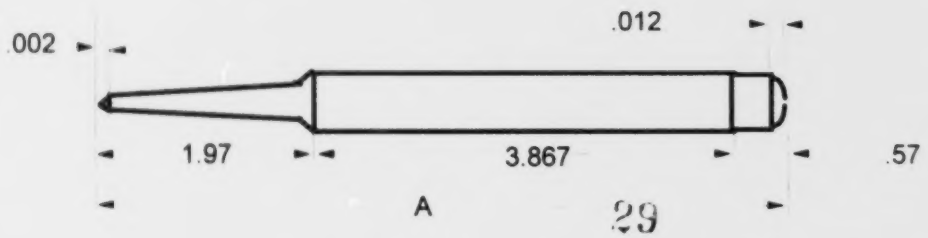
25. Find the missing dimensions. The hole is placed in the center of the plate. The radius of the hole is .56 inches.



26. The diameter of a circle is .67 inches. What is its radius?

The radius of a circle is 2.39 inches. What is its diameter?

27. What is the total length of this punch in inches?



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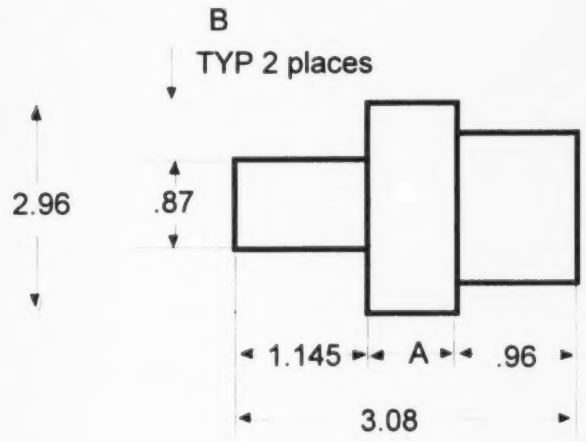
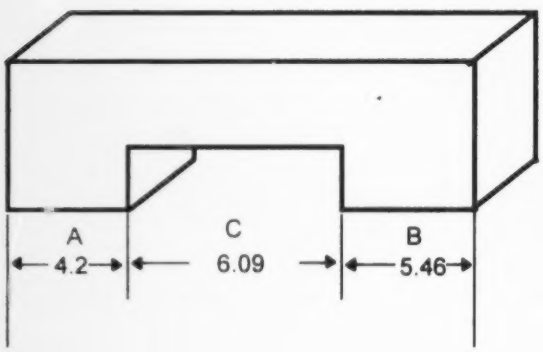
28. Find the missing dimensions:



29. A piece is cut to the dimensions shown. Has it been cut to within the specifications ?



Specifications on the blueprint:

A = 4.21 ± .02

B = 5.38 ± .02

Overall length = 15.74 ± .02

30. Washers are to be manufactured to the following thickness: .275 ± 0.002 An inspector measures and records the following thicknesses for six washers.

0.2702 0.278 0.276

0.27 0.274 0.275

Which ones are defective?

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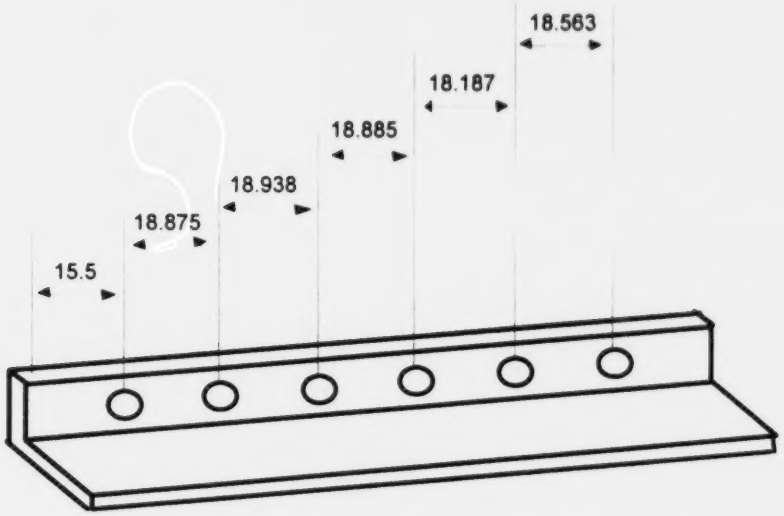
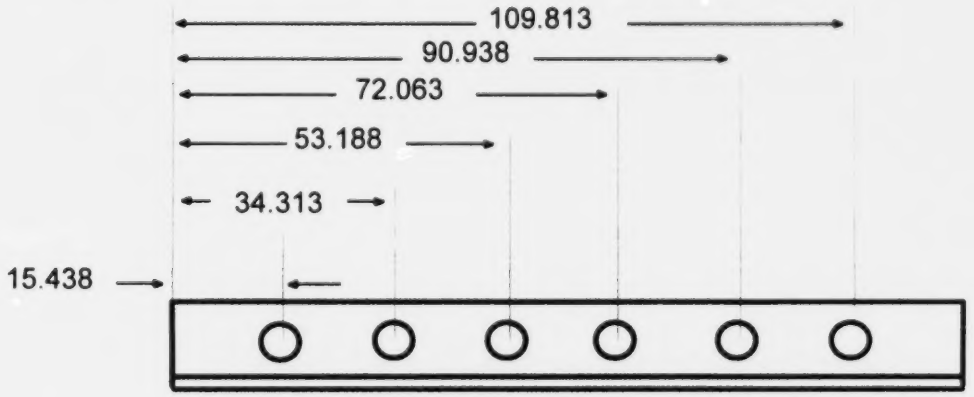
31. The drawing below gives the actual locations of six holes drilled in a length of angle iron.



The blueprint is shown below. The tolerance for all measurements is ±.125 inches. Find the upper and lower limit for each dimension on the blueprint below. Compare these limits with the measurements given above. Which holes are drilled incorrectly?



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LINEAR MEASUREMENT

A. Steel Rule (English)

- read measurements and measure lengths on decimal-inch steel rules

Steel rules (or tapes) are widely used for applications which do not require a high degree of precision. The steel rule is often the most practical measuring instrument to use for checking dimensions where stock allowances for finishing are provided. Steel rules are also used for locating roughing cuts on machined pieces and for determining the approximate locations of parts for machine setups. Steel rules used in the machine shop are generally six inches long.

Reading Decimal-Inch Rules

An enlarged decimal-inch rule is shown. The top scale is graduated in hundredths of an inch (0.01"). The bottom scale is graduated in fiftieths of an inch (0.02"). On the top scale there are 100 divisions per inch. On the bottom scale there are fifty divisions per inch. The longer lines represent tenths.

NOTE: Two hundredths = one fiftieth or $\frac{2}{100} = \frac{1}{50}$ *or .02 = one fiftieth*

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STEEL RULE (ENGLISH)

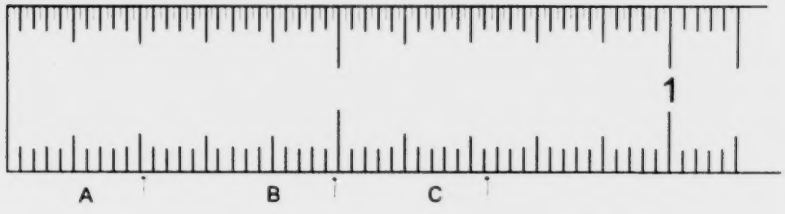
e.g. Read the following measurements on the enlarged decimal-inch rule shown above:

length A: 0.13"

length B: 0.70" = .7"

length C: $\frac{28}{50}$ = .56"

Often the edge of an object being measured does not fall exactly on a rule graduation. In these cases, read the measurement to the nearer rule graduation.



e.g. Read the following measurements, to the nearer graduation, on the enlarged decimal-inch rule shown:

A = .2"

B = .5"

C = .72"

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DIAL CALIPERS (ENGLISH)

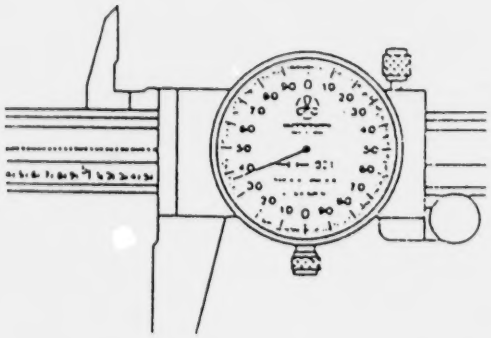
B. Dial Calipers (English)

- read and set given measurements on a decimal-inch dial caliper

Decimal-inch dial calipers are used in machine shop applications when the degree of precision to thousandths of an inch is adequate. They are used for measuring lengths of parts, distances between holes, and both inside and outside diameters of cylinders.

Dial Caliper

The basic parts of a dial caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a dial scale. The dial scale slides parallel to the main scale and provides a degree of precision to 0.001". A dial caliper which is commonly used in machine shops is shown.



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DIAL CALIPERS (ENGLISH)

Reading a Measurement on a Decimal-Inch Dial Caliper

To read a measurement on a decimal-inch dial caliper,
(1) read the number of 1" graduations and the 0.1" graduations on the main scale,
(2) read the number on the dial indicating the 0.001" graduation, and
(3) add the numbers together to obtain the length.

e.g. to read the measurement on the dial caliper shown
(1) there is 5" plus 0.5" on the main scale
(2) there is 0.037" on the dial
(3) so, add: 5.0" + 0.5" + 0.037" = 5.537"

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ENGLISH MICROMETER

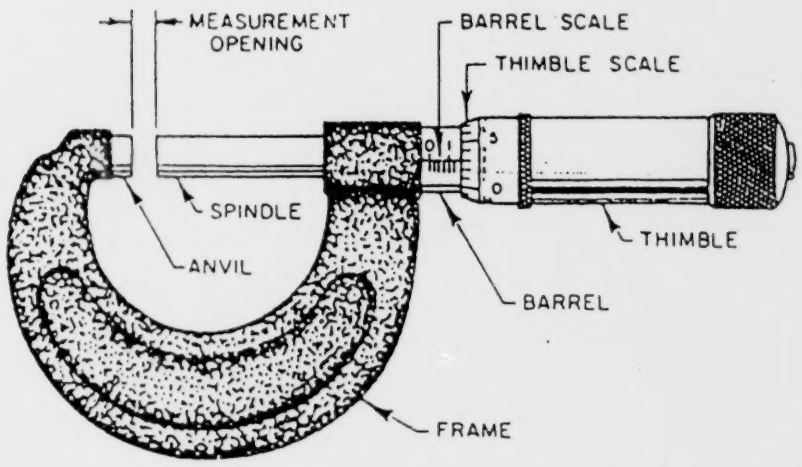
C. English Micrometer

- read given measurements on the barrel and thimble scales of 0.001-inch micrometers

Micrometers are basic measuring instruments used by machinists in the processing and checking of parts. Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders.

The 0.001-Inch Micrometer

The 0.001-inch micrometer is shown with its principal parts labeled.



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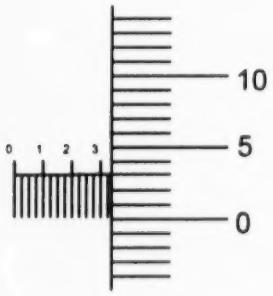
ENGLISH MICROMETER

Reading a 0.001-Inch Micrometer



e.g. read the micrometer setting shown

(1) observe the greatest 0.100-inch division on the barrel scale, (three 0.100" = 0.300")
(2) observe the number of 0.025-inch divisions between the 0.300-inch mark and the thimble, (one 0.025" = 0.025")
(3) add the thimble scale reading that coincides with the horizontal line on the barrel side, (three 0.001" = 0.003")
(4) micrometer reading:
0.300" + 0.025" + 0.003" = 0.328"

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DEGREE OF PRECISION

D. Degree of Precision
- determine the degree of precision of commonly used measuring instruments

The degree of precision specified for a particular machining operation dictates the type of machine, the machine setup, and the measuring instrument used for that operation. Since the exact length of an object cannot be measured, by increasing the number of graduations on a measuring instrument, the degree of precision is increased.

The precision of measurement depends on the measuring instrument used. The degree of precision of a measuring instrument depends on the smallest graduated unit of the instrument.

Limitations of Measuring Instruments

Following are the limitations on the degree of precision possible of some measuring instruments:

Steel rule (decimal inch)
0.01" or .02" (depending on the smallest gradation)

Micrometers: 0.001" (decimal inch)
Dial calipers: 0.001" (decimal inch)

Degree of Precision of Numbers

The degree of precision of a number depends upon the unit of measurement. The degree of precision of a number increases as the number of decimal places increases.

e.g. degree of precision of:	to the nearest:
2"	inch
2.0"	tenth of an inch
2.00"	hundredth of an inch
2.000"	thousandth of an inch

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UNITS OF MEASURE (ENGLISH)

E. Units of Measure (English)
- express an English unit of measure in larger or small units of measure

The ability to measure with tools and instruments and to compute measurements is a basic requirement in the machine trades. Presently, the United States uses both the English and the Metric systems of measure. Although these systems include all types of measure (length, area, volume, capacity), the machine trades use length measure most often.

English Units of Linear Measurement

1 yard (yd.) = 3 feet (ft.)
1 yard (yd.) = 36 inches (in.)
1 foot (ft.) = 12 inches (in.)

Expressing English Units of Measure as Smaller/Larger Units

To express a larger unit of length as a smaller unit of length, multiply the given length by the number of smaller units contained in one of the larger units.

e.g. express 2.5 feet as inches

since there are 12 inches in 1 foot,

multiply 2.5 by 12

2.5 x 12 = 30

so 2.5 ft = 30 in

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UNITS OF MEASURE (ENGLISH)

To express a smaller unit of length as a larger unit of length, divide the given length by the number of smaller units contained in one of the larger units.

e.g. express 67 inches as feet

since there are 12 inches in 1 foot, divide 67 by 12

$67 \div 12 = 5.583$

so 67 in. = 5.583 ft.

or $12\overline{)67}$ $\begin{matrix}5\\ \\ \end{matrix}$ remainder 7

so 67 inches = 5 feet 7 inches

Alternate Method

e.g. Express 2.5 feet as inches

Use the chart given above to write a conversion factor:

$$\frac{12 \text{ inches}}{1 \text{ foot}} \text{ or } \frac{1 \text{ foot}}{12 \text{ inches}}$$

Multiply:

Correct: $\frac{2.5 \text{ ft.}}{1} \times \frac{12 \text{ in.}}{1 \text{ ft.}} = 30 \text{ in.}$

(NOTE: $\frac{\text{ft}}{\text{ft}} = 1$ leaving inches as the units)

Incorrect: $\frac{2.5 \text{ ft.}}{1} \times \frac{1 \text{ ft.}}{12 \text{ in.}} = ??$

The placement of the units will tell you if your calculation is done correctly.

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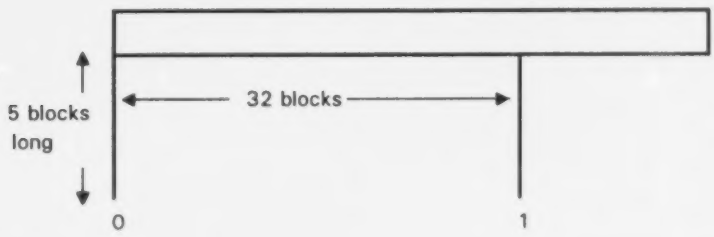
DIRECTIONS FOR CONSTRUCTING AN ENLARGED RULER

1. Hold the graph paper lengthwise. Make a rectangle the entire length of the paper.

2. Mark zero
   - Count over 32 lines and mark 1
   - Make each line 5 blocks long on the graph paper.



3. Place $\frac{1}{4}$ $\frac{2}{4}$ $\frac{3}{4}$ $\frac{4}{4}$ on the ruler.

   Make each new line 4 blocks long.

4. Place $\frac{1}{8}$ $\frac{2}{8}$ . . . . . $\frac{8}{8}$ on the ruler.

   Make each new line 3 blocks long.

5. Place $\frac{1}{16}$ $\frac{2}{16}$ . . . . . $\frac{16}{16}$ on the ruler.

   Make each new line 2 blocks long.

6. Place $\frac{1}{32}$ $\frac{2}{32}$ . . . . . $\frac{32}{32}$ on the ruler.

   Make each new line 1 block long

PRE-BLUEPRINT MATH ◆ PROBLEM SET 2

LINEAR MEASUREMENT

1. Determine the length of each measurement.

2. Determine the length of each measurement.

3. Determine the length of each measurement.

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4. Measure the length of each line first using a steel rule and then the dial caliper. What is the precision of each measuring instrument? Which is more accurate in this situation?

	ruler	dial caliper
a.	a.	
b.	b.	
c.	c.	
d.	d.	

5. Measure the diameter of the circle below. What is its radius? With what precision are you making this measurement?

6. What is the largest measurement you can make with your:

   a. steel rule _____

   b. dial caliper _____

   c. micrometer _____

7. What is the difference between tolerance and precision?

_____

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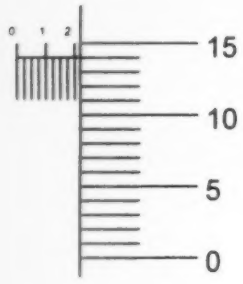
8. Determine the value of each micrometer reading.



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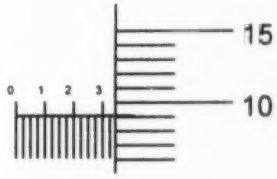

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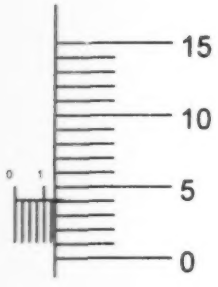

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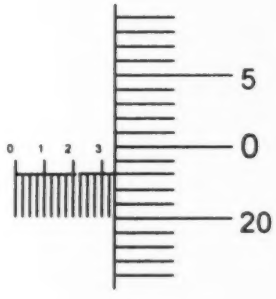

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9. Express the English units of measure in larger or smaller unit of length.

3 ft 7 in = _____ in. 6 yd 4 ft = _____ ft.

70 ft = _____ yd. 80 in = _____ ft.

5 yd = _____ ft.

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PRE-BLUEPRINT MATH ◆ SESSION 3

COMMON FRACTIONS AND MIXED NUMBERS

A. Basic Skills:
- express fractions in lowest terms and as equivalent fractions
- express mixed numbers as improper fractions
- express improper fractions as mixed numbers
- comparison of fractions
- fractions as blueprint dimensions

Most measurements and calculations made by a machinist are not limited to whole numbers. Blueprint dimensions are often given as **fractions** and most measurement tools are graduated in **fractional units**.

Definitions

Fractions

- a value which represents part of a whole
- expressed as $\frac{\text{numerator (x)}}{\text{denominator (y)}} \Longrightarrow \frac{x}{y}$

e.g. $\frac{1}{2}$ $\frac{9}{16}$

Proper Fractions

- numerator is smaller than denominator

e.g. $\frac{3}{8}$ $\frac{15}{16}$

Improper Fractions

- numerator is larger than denominator

e.g. $\frac{11}{8}$ $\frac{13}{12}$

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BASIC SKILLS

Mixed Numbers

- contains a whole number as well as a fraction

e.g. $1\frac{2}{3}$ $5\frac{1}{2}$

Lowest Terms

To express these fractions in lowest terms, "reduce" them by dividing both numerator and denominator by their greatest common factor.
Explanation:

$$\frac{6 \div 2}{16 \div 2} = \frac{3}{8} \qquad \frac{8 \div 8}{16 \div 8} = \frac{1}{2} \qquad \frac{12 \div 4}{16 \div 4} = \frac{3}{4}$$

Equivalent Fractions

To express these fractions as equivalent fractions with a new denominator:
(1) divide the original denominator into the new denominator and
(2) multiply both the numerator and denominator of the original fraction by the value obtained.

(1) $\frac{8}{16} = \frac{\quad}{32}$ $\qquad (32 \div 16 = 2)$

(2) $\frac{8 \times 2}{16 \times 2} = \frac{16}{32}$

Mixed Numbers and Improper Fractions

e.g. Mixed Number => Improper Fraction

$2\frac{1}{4}$ => $4 \times 2 + 1$ => $\frac{9}{4}$

Improper Fraction => Mixed Number

$\frac{7}{4}$ => $4\overline{)7}^{\,1}$ => $\frac{3}{4}$

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BASIC SKILLS

Comparison of Fractions

To compare any two given fractions using < (less than), > (greater than), or = (equal to), change them to equivalent fractions with common denominators:

example:

Which is bigger $\frac{3}{8}$ or $\frac{3}{16}$?

$$\frac{3}{8} = \frac{6}{16}$$

therefore

$$\frac{3}{8} > \frac{3}{16}$$

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ADDITION/SUBTRACTION SKILLS

B. Addition/Subtraction Skills:
- determine least common denominator
- rewrite fractions as equivalent fractions using least common denominator
- add/subtract fractions and mixed numbers

A machinist must be able to add fractions and mixed numbers in order to **determine the distance between parts of a machined piece** and to **determine** depth of holes and cutouts. While making a part from a blueprint, a machinist often finds it necessary to express blueprint dimensions as working dimensions. Subtraction of fractions and mixed numbers is required to properly position a part on a machine, to establish hole locations, and to determine depths of cut.

To determine the LCD, find the smallest number into which all denominators divide into evenly.

The LCD for: $\frac{1}{8}$, $\frac{3}{4}$, $\frac{9}{16}$ is 16
because 8, 4, and 16 divide evenly into 16.

Adding Fractions/Mixed Numbers

To add fractions, express fractions as equivalent fractions with the LCD, add numerators, denominator remains the same. Reduce to lowest terms or express improper fractions as mixed numbers.

e.g. Add $\frac{1}{8} + \frac{3}{4}$

$$\frac{1}{8} = \frac{1}{8}$$

$$\frac{3}{4} = \frac{6}{8}$$

$$\frac{7}{8}$$

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ADDITION/SUBTRACTION SKILLS

To add mixed numbers, add the whole numbers, add the fractions, combine whole numbers and fractions.

e.g. $4\frac{1}{2} = 4\frac{12}{24}$

$+ 2\frac{13}{24} = 2\frac{13}{24}$

$6\frac{25}{24} = 7\frac{1}{24}$

Subtracting Fractions and Mixed Numbers

Follow addition rules, except:

If fractions cannot be subtracted, one whole unit must be borrowed and expressed as a fraction.

e.g. $9\frac{5}{8} = 9\frac{10}{16} \Rightarrow 8\frac{26}{16}$

$- 6\frac{15}{16} = 6\frac{15}{16} \Rightarrow - 6\frac{15}{16}$

$2\frac{11}{16}$

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MULTIPLICATION/DIVISION SKILLS

C. Multiplication/Division Skills:
- multiply fractions and mixed numbers
- cancel common factors
- compute parts of a fractions
- compute threads per inch
- divide fractions and mixed numbers

In machine technology, multiplication and division of fractions and mixed numbers are used to determine distances between parts of a machined piece and to calculate pitch of screw heads.

Multiplying fractions

To multiply fractions, multiply across numerators and across denominators. Reduce to lowest terms.

e.g. $\frac{2}{3} \times \frac{9}{16} = \frac{18}{48} = \frac{3}{8}$

To multiply mixed numbers, express mixed numbers as improper fractions and multiply as fractions.

e.g. $3\frac{1}{2} \times 1\frac{3}{21} = \frac{7}{2} \times \frac{24}{21} = \frac{4}{1} = 4$

To determine a fractional part of a given amount, multiply the fractions.

e.g. What is half of $\frac{1}{16}$?

$$\frac{1}{2} \times \frac{1}{16} = \frac{1}{32}$$

e.g. What is twice as much as $\frac{3}{4}$?

$$\frac{2}{1} \times \frac{3}{4} = \frac{6}{4} = 1\frac{1}{2}$$

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MULTIPLICATION/DIVISION SKILLS

Dividing Fractions

To divide fractions, change to multiplication problem by inverting the divisor, and multiply as fractions.

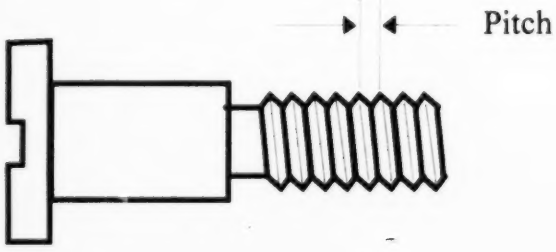
e.g. $\frac{5}{8} \div \frac{2}{3} =$

$\frac{5}{8} x \frac{3}{2} =$

$\frac{15}{16}$

Threads per inch

The pitch of a thread is the distance from a given point on one thread to the corresponding point on the next thread. Pitch is usually expressed as a fraction.



If the number of threads are known in a given length, divide the length by the number of threads to determine threads per inch.

e.g. A screw is 5 inches long and has 45 threads. How many TPI?

45 ÷ 5 = 9 T.P.I.

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TOLERANCES

D. Tolerances

- compute tolerances based on upper and lower limits of dimension

In industry, the tolerance of a part or component is the acceptable amount that the part or component may vary from a given size.

Definitions

Tolerance is the amount of variation permitted on the dimensions or surfaces of manufactured parts. Limits are the extreme permissible dimensions of a part. Tolerance is equal to the difference between the upper and lower limits of any specified dimension of a part.

The tolerance of the hole is:

$$3\frac{1}{2}'' \quad \pm \quad \frac{1}{8}''$$

therefore, the diameter of a hole has

- an upper limit of $3\frac{5}{8}$ inches
- a lower limit of $3\frac{3}{8}$ inches

The tolerance interval is the difference between the upper and lower limit,

$$\frac{2}{8} \quad \text{or} \quad \frac{1}{4} \text{ inch.}$$

A basic dimension is the standard size from which the maximum and minimum limits are determined. Tolerances are shown with the amount of variation and the direction from the basic dimension the variation an occur.

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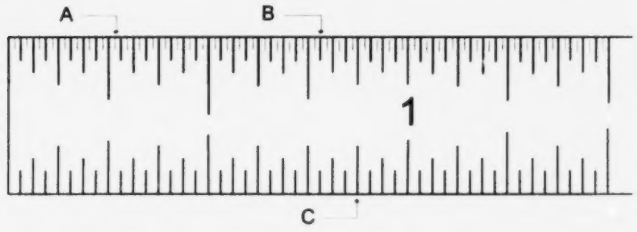
READING FRACTIONAL-INCH RULES

E. Reading Fractional-Inch Rules



The top scale is sixty-fourths. (There are 64 divisions in 1 inch.)
The bottom scale is thirty-seconds. (There are 32 divisions in one inch.)

e.g. Read the following measurements on the enlarged fractional-inch rule shown:

length A: $\frac{17}{64}$ length B: $\frac{25}{32}$ length C: $\frac{7"}{8}$

Often the edge of an object being measured does not fall exactly on a rule graduation. In these cases, read the measurement to the nearer rule graduation.

e.g. Read the following measurements, to the nearer graduation, on the enlarged fractional-inch rule shown:

length E: $1\frac{3"}{32}$ length F: $1\frac{3"}{8}$

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PRE-BLUEPRINT MATH ◆ PROBLEM SET 3

COMMON FRACTIONS AND MIXED NUMBERS

1. Express fractions in lowest terms.

$\frac{32}{32} =$ $\frac{15}{1} =$ $\frac{6}{8} =$

$\frac{0}{8} =$ $\frac{14}{16} =$ $\frac{12}{16} =$ $\frac{14}{64} =$

2. Express as equivalent fractions.

$\frac{5}{16} = \frac{}{32}$ $\frac{1}{8} = \frac{}{16}$ $\frac{15}{4} = \frac{}{64}$

$\frac{12}{32} = \frac{}{8}$ $\frac{7}{1} = \frac{}{16}$ $\frac{10}{8} = \frac{}{32}$

3. Express mixed numbers as improper fractions.

$6\frac{3}{4} =$ $2\frac{1}{8} =$ $4\frac{1}{2} =$ $6\frac{7}{8} =$

4. Express improper fractions as mixed numbers.

$\frac{11}{4} =$ $\frac{67}{16} =$ $2\frac{70}{16} =$

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5. Compare fractions using <, >, or =.

$\frac{13}{16}$ $\frac{3}{4}$ $\frac{15}{32}$ $\frac{30}{64}$

$\frac{1}{2}$ $\frac{8}{16}$ $\frac{3}{8}$ $\frac{24}{64}$

6. Determine the least common denominator for each set of fractions.

$\frac{1}{2}$ $\frac{1}{8}$ $\frac{1}{16}$ _____

$\frac{1}{4}$ $\frac{1}{16}$ $\frac{7}{8}$ _____

$\frac{3}{32}$ $\frac{1}{16}$ $\frac{5}{64}$ _____

7. Rewrite each of the above fractions as equivalent fractions using the least common denominator.

_____

_____

_____

8. Add the following fractions and mixed numbers.

$2\frac{1}{2} + 1\frac{3}{8} =$ _____ $\frac{1}{16} + \frac{3}{32} =$ _____

$3\frac{7}{8} + \frac{5}{16} =$ _____ $4\frac{3}{16} + \frac{1}{8}\ 5\frac{1}{4} =$ _____

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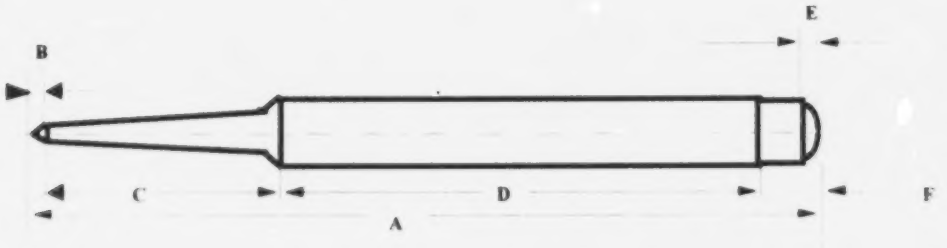
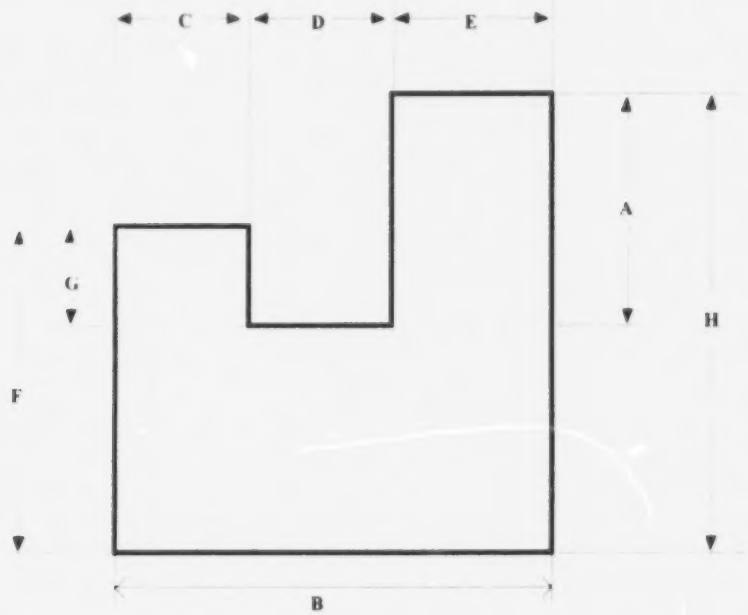
14. Find the overall length.



$B = \frac{3"}{32}$ $C = 2\frac{1"}{4}$ $D = 3"$ $E = \frac{3"}{32}$ $F = \frac{3"}{8}$

A = _____

15. Find dimensions & B on this support bracket.



$C = 1\frac{1"}{16}$ $D = 1\frac{3"}{32}$ $E = 1\frac{5"}{64}$ $F = 3\frac{7"}{8}$ $G = \frac{15"}{16}$ $H = 5\frac{1"}{16}$

A = _____

B = _____

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16. Multiply the following as indicated.

$8 \times \frac{1}{2} =$_____ $\frac{3}{4} \times 12 =$_____ $\frac{3}{4} \times \frac{5}{16} =$_____

17. Divide the following.

$\frac{3}{8} \div \frac{1}{4} =$_____ $\frac{1}{2} \div \frac{1}{4} =$_____ $15 \div \frac{3}{8} =$_____

18. Determine the following.

What is $\frac{1}{2}$ of $\frac{3}{16}$? _____

What is half of $\frac{7}{8}$? _____

What number is twice as large as $\frac{1}{32}$? _____

19. The diameter of a circle is $4\frac{3"}{4}$. What is its radius?

_____

The radius of a circle is $\frac{3"}{8}$. What is its diameter?

_____

20. A screw 6 inches long has 48 threads. How many threads per inch are there?

_____

A screw has a pitch of $\frac{1"}{16}$. How many threads per inch are there?

_____

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21. How much wire is needed to produce 38 pieces, each measuring $24\frac{3"}{8}$ in length?

_____

22. A room has a board for brass checks which has 48 hooks on a horizontal line. The first and last hooks are $1\frac{1"}{4}$ from the ends. The hooks in between are $1\frac{1"}{8}$ apart. What is the length of the board?

_____

23. A roll of sheet steel is 180 ft. long and 4 ft. wide. How many pieces 2 ft. long and 3 ft. wide can be produced from this roll?

_____

24. Complete the following table.

Given measurement	Tolerance	Upper limit	Lower limit	Tolerance interval
$3\frac{1}{2}$ in.	$\pm\frac{1}{8}$ in.	$3\frac{5}{8}$ in.	$3\frac{3}{8}$ in.	$\frac{1}{4}$ in.
$5\frac{3}{4}$ in.	$\pm\frac{1}{16}$ in.			
$6\frac{5}{8}$ in.	$\pm\frac{1}{32}$ in.			
$3\frac{7}{16}$ in.	$\pm\frac{1}{64}$ in.			
$\frac{9}{64}$ in.	$\pm\frac{1}{128}$ in.			

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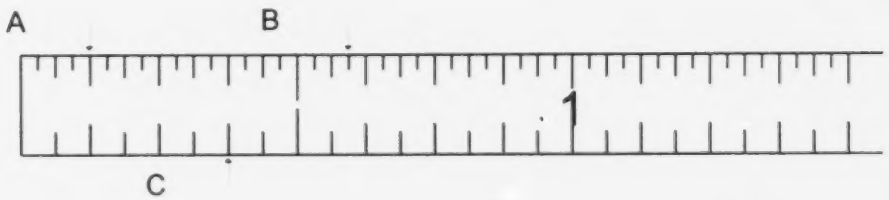
25. Determine the length of each measurement.

_____

26. Determine the length of each measurement.



_____

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27. The drawing in figure I gives the locations and tolerances of 6 holes that are to be drilled in a length of iron.

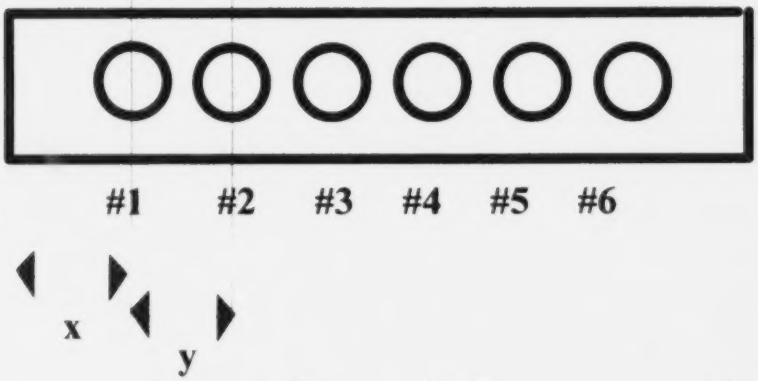
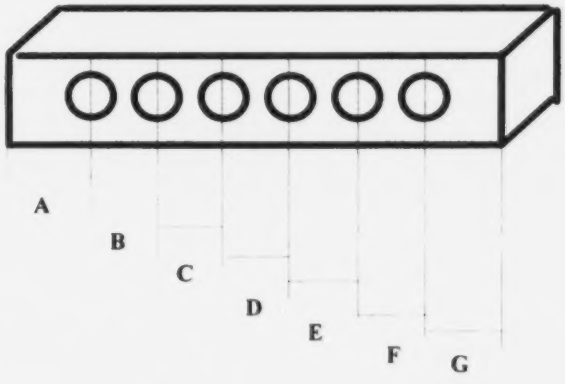


Figure I

$x = 4\frac{7"}{16} \pm \frac{1"}{8}$ Typical 2 places

$y = 6\frac{7"}{8} \pm \frac{1"}{32}$ Typical 5 places

A machinist drills the holes and checks them for proper location. The actual locations of the drilled holes are shown in Figure II. Which holes are drilled out of tolerance?



$A = 4\frac{1"}{2}$ $B = 6\frac{15"}{16}$ $C = 6\frac{57"}{64}$ $D = 6\frac{54"}{64}$ $E = 6\frac{13"}{16}$ $F = 6\frac{1"}{4}$ $G = 4\frac{1"}{4}$

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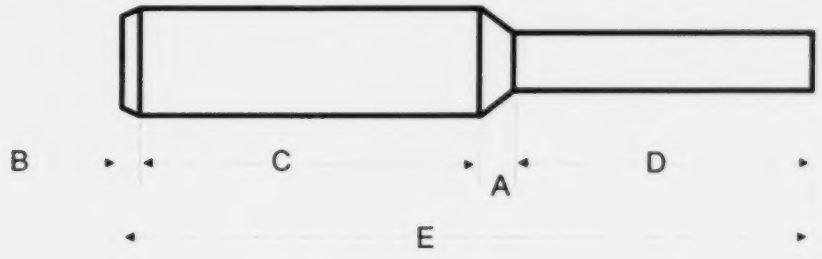
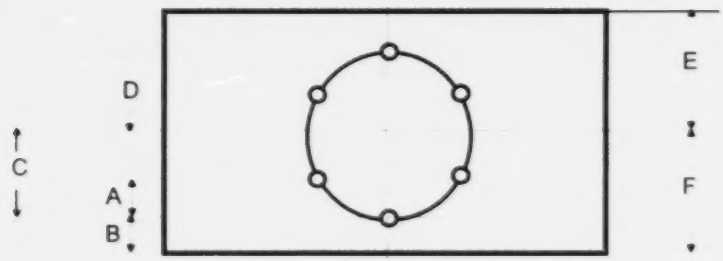
28. Determine dimension A



$B = \frac{3}{32}$ $C = 3\frac{5}{64}$ $D = 2\frac{1}{16}$ $E = 5\frac{9}{32}$

A = _____

29. Determine dimensions A and B



$C = \frac{3}{4}$ $D = \frac{17}{32}$ $E = \frac{1}{4}$ $F = \frac{1}{4}$

A = _____

B = _____

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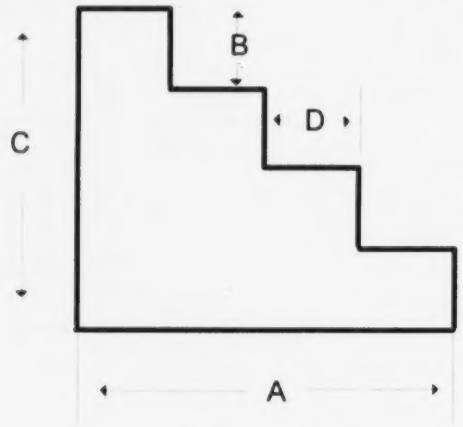
30. Determine dimensions A and B:
All steps are equal in size.

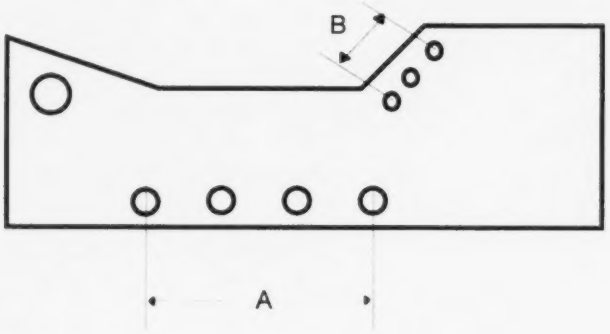


$C = 3\frac{1}{8}$ $D = \frac{3}{4}$

A = _____

B = _____

31. Compute the distance between 2 consecutive holes for each set of drilled holes.



$A = 3\frac{1}{8}$ $B = 2\frac{1}{16}$

_____

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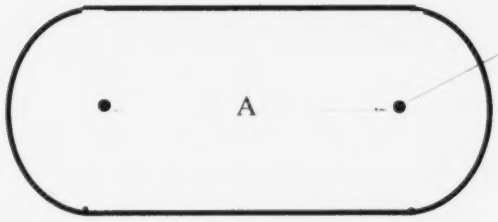
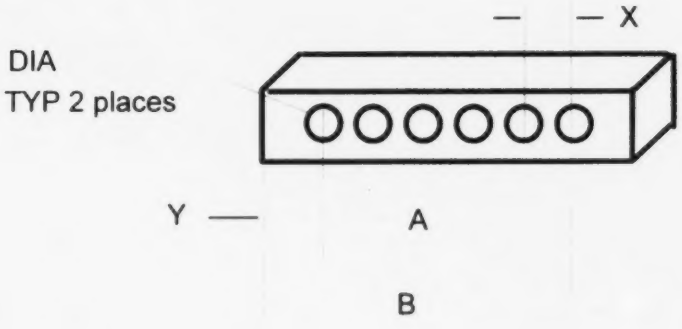
32. In this drawing of a plate, determine the overall length.



Radius = $\frac{5}{8}$ A = $2\ \frac{3}{16}$

_____

33. In the support bracket shown, find dimensions X and Y.



Diameter = $\frac{3}{16}$ A = $2\ \frac{7}{8}$ B = $3\ \frac{1}{8}$

X = _____

Y = _____

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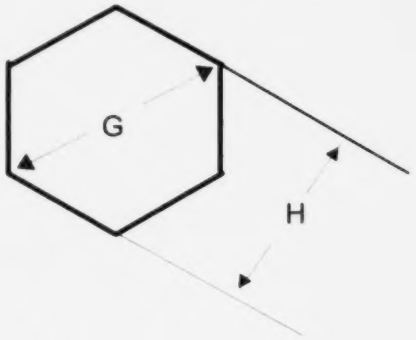
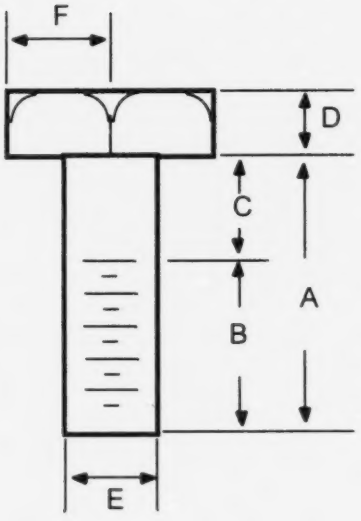
34. Find the following measurements on the bolt given to you by your instructor.





A = _____

B = _____

C = _____

D = _____

E = _____

F = _____

G = _____

H = _____

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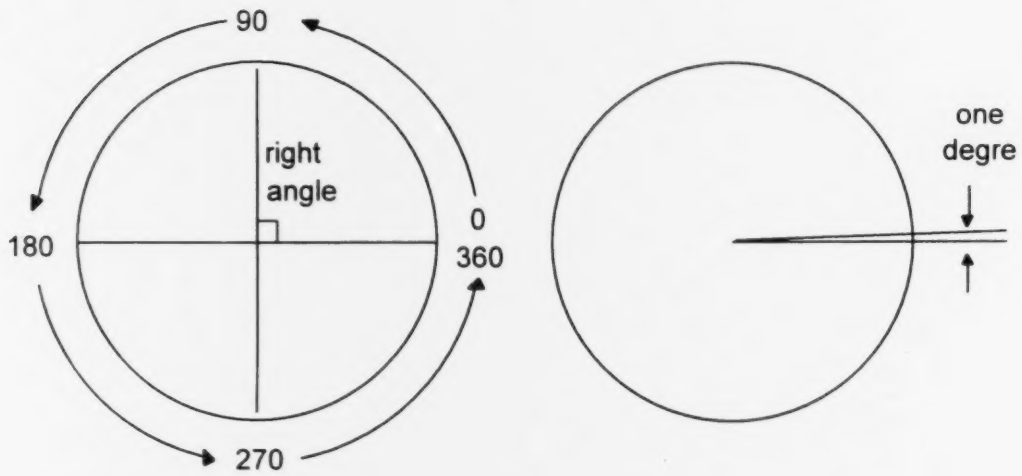
PRE-BLUEPRINT MATH ◆ SESSION 4

ANGULAR MEASUREMENT

A. Basic Skills
- measure angles using degrees
- measure internal and external angles

The fundamental principles of geometry generally applied to machine shop problems are those used to make the calculations required for machining parts from engineering drawings. An engineering drawing is an example of applied geometry.

Units of Angular Measure



1 circle = 360°

$\frac{1}{2}$ circle = 180°

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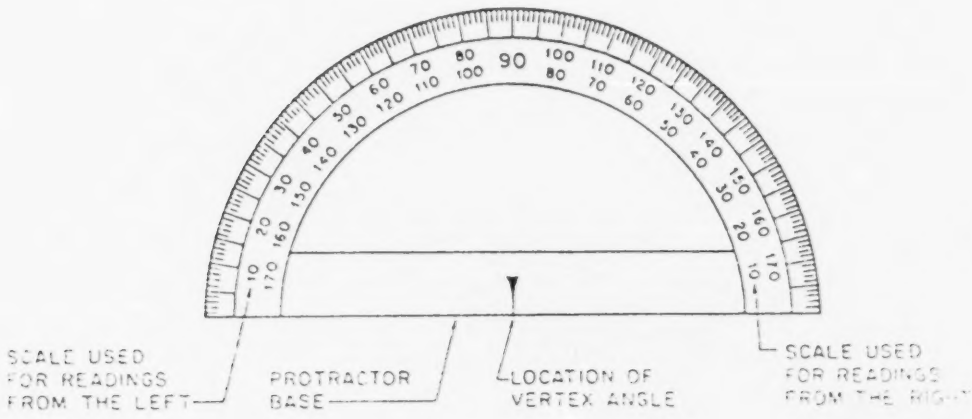
PROTRACTORS (SIMPLE AND VERNIER)

B. Protractors (Simple and Vernier)

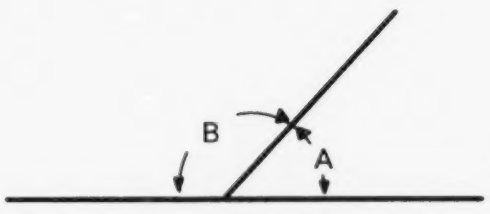
- measure angles with a simple protractor
- compute complements and supplements of angles

Protractors are used for measuring and laying out angles. Although all protractors are basically the same, different types are available for different uses and degrees of precision required.

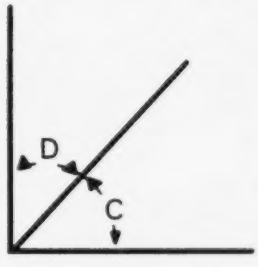
Simple Protractor



Complements and Supplements of Scale Readings



Supplementary angles = 180



Complementary angles = 90

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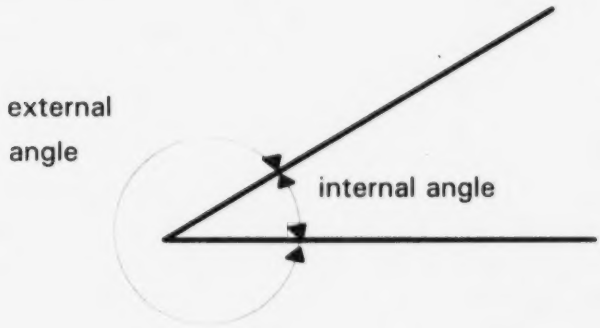
PROTRACTORS (SIMPLE AND VERNIER)

Internal and External Angles



internal angle + external angle = 360°

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PRE-BLUEPRINT MATH ◆ PROBLEM SET 4

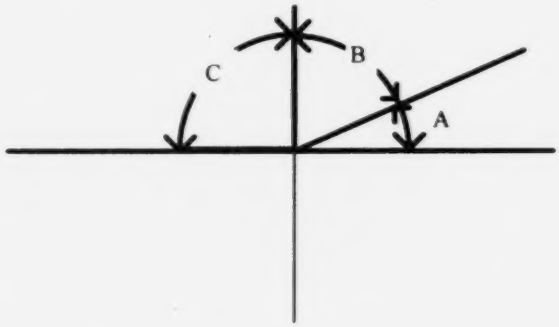
ANGULAR MEASUREMENT

In the English systems, angles are measured in degrees.

1. How many degrees are there is a right angle? How many degrees are there is two right angles? How many 60-degree angles are there in two right angles?

_____ _____ _____

2. From the following diagram, determine the value of angle B if angle A is 30 degrees. Angle C is 90 degrees.



A = 30°

B = _____

C = _____

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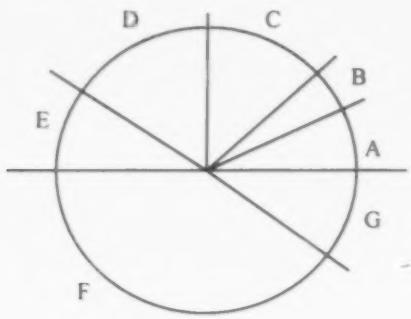
3. In the following circle; angle A = 30 degrees, angle B = 20 degrees, angle D = 65 degrees, and angle F = 118 degrees.



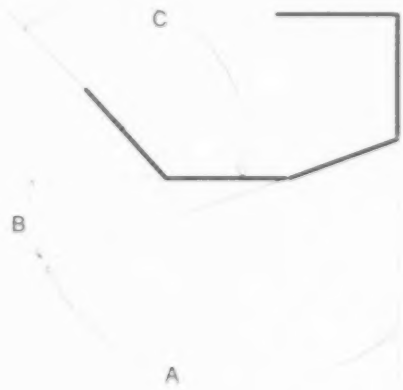
What is the sum of angles A and B? Angles A, B, and C total 90 degrees.
Find the value of angel C.
What is the sum of angles A, B, C, and D?
Find the value of angle E.
What is the sum of angles A, B, C, D, E, and F? Find angle G.

A + B = _____ A + B + C + D + E + F = _____

C = _____ A + B + C + D = _____

E = _____ G = _____

4. In the following diagram, if angle A is 78 degrees and angle B is 30 degrees and angle C is 135 calculate all the internal angles.



C = _____

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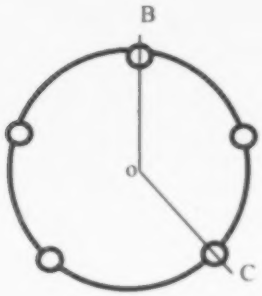
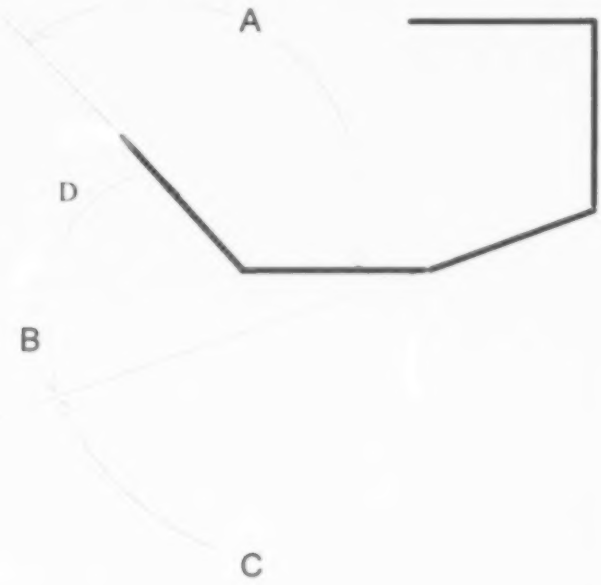
5. A layout of five holes equally spaced on a 10-inch circle is shown. What angle is formed by connecting the centers of holes B and C with the center?

_____



6. Using a simple protractor, measure angles A, B, C, and D.



A = _____ B = _____

C = _____ D = _____

Calculate angle E and F.

E = _____ F = _____

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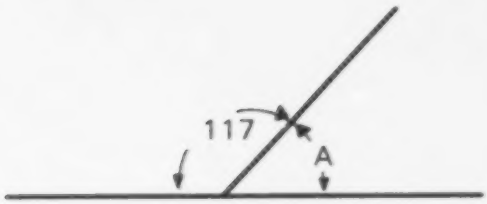
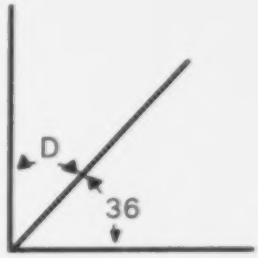
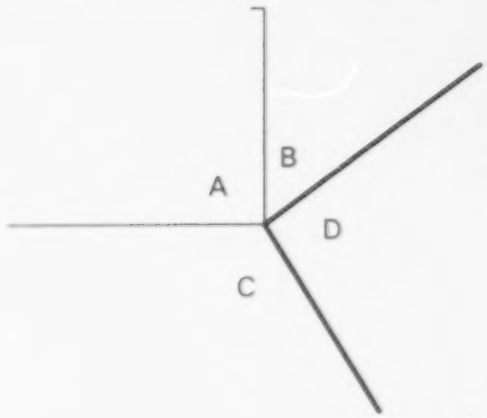
7. Find Angle A and angle D.





$\angle A$ = _____ $\angle D$ = _____

8. Find angle D if angle A is a right angle, angle B = 35 ° and angle C = 110°.



$\angle D$ = _____

9. What is the internal angle with an external angular measurement of 275°?

_____

10. What is the external angle with an internal angular measurement of 35°?

_____

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PRE-BLUEPRINT MATH

Pretest

1. Express each of the following fractions as equivalent fractions as indicated.

$\frac{3}{8} = \frac{\quad}{32}$ $\qquad\qquad$ $\frac{1}{4} = \frac{\quad}{64}$

2. Express each of the following mixed numbers as improper fractions.

$3\frac{1}{5}$ = _____ $\qquad\qquad$ $5\frac{3}{4}$ = _____

3. Express each of the following improper fractions as mixed numbers.

$\frac{5}{2}$ = _____ $\qquad\qquad$ $\frac{75}{4}$ = _____

4. Express each of the following fractions as a fraction in lowest terms.

$\frac{8}{16}$ = _____ $\qquad\qquad$ $\frac{30}{32}$ = _____

5. What is half of $\frac{1}{8}$?

What is half of .001 ?

6. Add or subtract each of the following values. Express the answers in lowest terms.

$\frac{1}{8} + \frac{5}{8}$ = _____ $\qquad\qquad$ $\frac{5}{8} + \frac{13}{32}$ = _____

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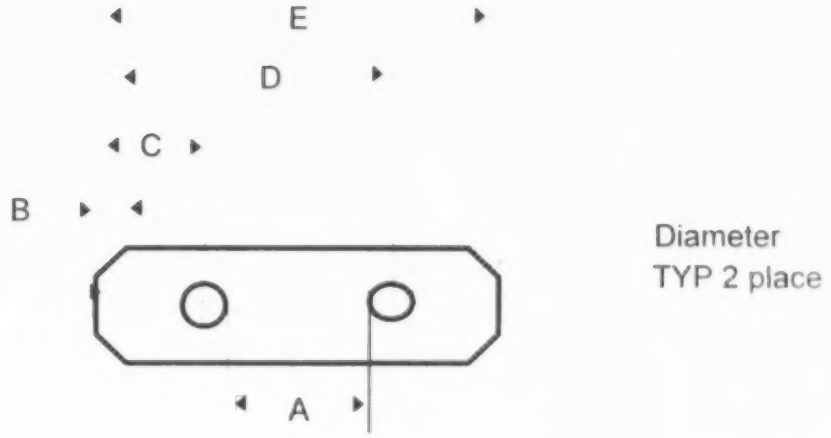
PRE-BLUEPRINT MATH

7. Multiply or divide each of the following values. Express the answers in lowest terms.

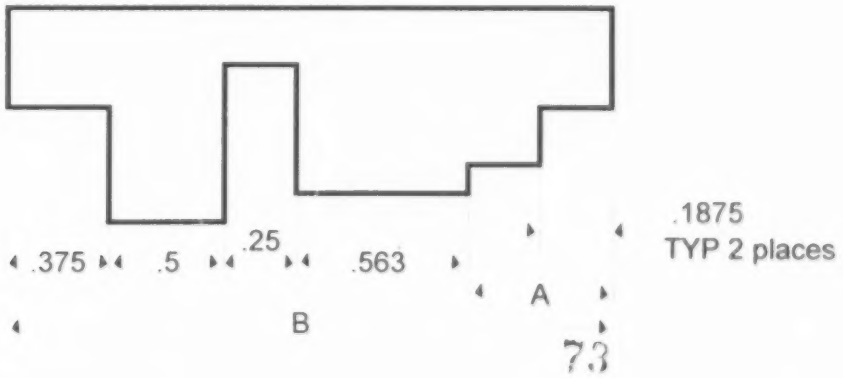
$32 \times \frac{5}{8} =$ _____ $\frac{29}{32} \div \frac{3}{4} =$ _____

8. Find A.



B = $\frac{1}{4}$ C = $\frac{25}{32}$ D = $3\frac{7}{32}$ E = 4 Diameter = $\frac{5}{16}$

9. Compute dimensions A and B of the support bracket shown. All dimensions are given in inches.



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PRE-BLUEPRINT MATH

10. Write each of the following numbers as words.

    0.6 _____

    0.147 _____

11. Write each of the following numbers .

    three tenths _____

    nine and twenty-six thousandths _____

12. Round each of the following numbers to the indicated number of decimal places.

    0.596 (hundredths) _____

    0.80729 (thousandths) _____

13. Express each of the following common fractions as decimal fractions. Where necessary, round the answers to 3 decimal places.

    $\frac{3}{4}$ = _____ $\frac{2}{3}$ = _____

14. Express each of the following decimal fractions as common fractions in lowest terms.

    2.7 = _____ .019 = _____

15. Add or subtract each of the following values.

    23 + .007 + 0.4 = _____

    0.59 - .0038 = _____

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PRE-BLUEPRINT MATH

16. Multiply or divide each of the following values. Round the answer to 4 decimal places where necessary.

    12.3 x 0.6 = _____

    24 ÷ 0.48 = _____

17. Find the decimal or fraction equivalents of each of the following numbers using the decimal equivalent table.

    $\frac{5}{8}$ = _____ 0.328125 = _____

18. Determine the nearer fractional equivalents of each of the following decimals using the decimal equivalent table.

    0.465 = _____ 0.038 = _____

19. Express each of the following lengths as indicated.

    81 inches as feet = _____

    9.6 yards as feet = _____

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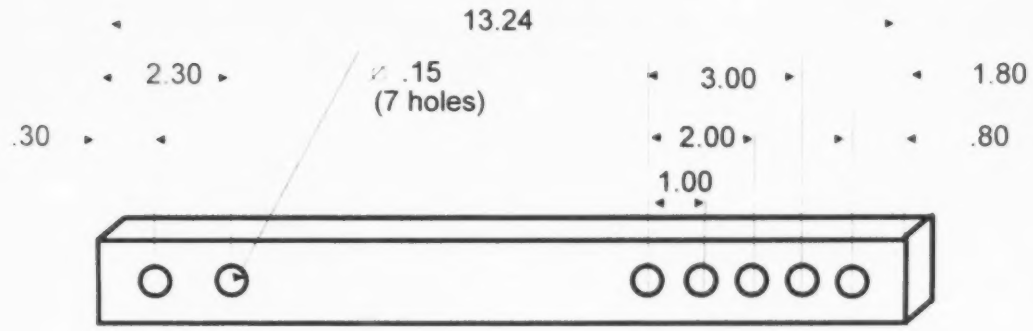
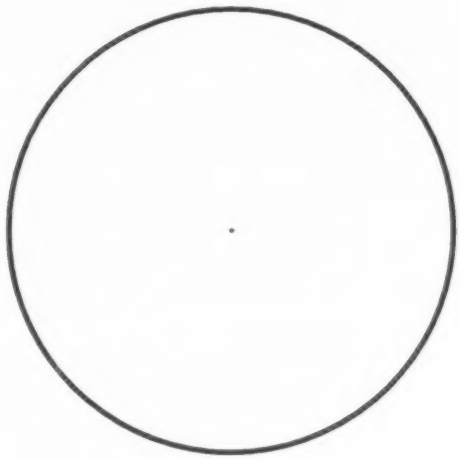
PRE-BLUEPRINT MATH

20. Holes are to be drilled in the length of angle iron as shown. What is the distance between the 2 holes on the left hand side? Are the holes on the right hand side spaced evenly apart?



21. Using a steel rule, find the diameter and radius of the circle drawn below:



22. The following dimension has a tolerance as given. Determine the maximum dimension (upper limit) and the minimum dimension (lower limit).

1.714 ± 0.005 = _____ _____

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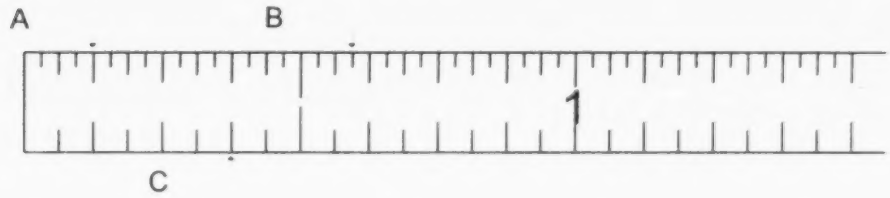
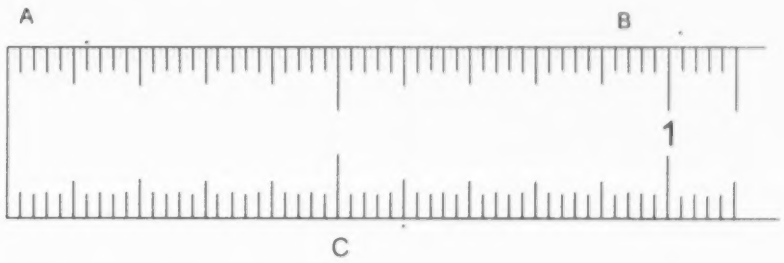
PRE-BLUEPRINT MATH

23. Read the measurements A-C on the enlarged fractional rule shown.



24. Read the measurements A-C on the enlarged decimal-inch rule shown.



25. Measure the lengths of the following line segments using dial calipers.

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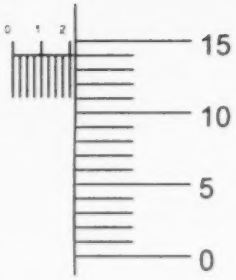
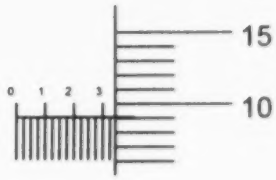
PRE-BLUEPRINT MATH

26. Read the setting on the following micrometer scales.

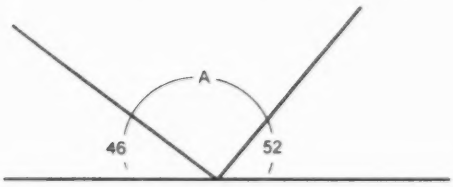
0.001 Decimal-Inch Micrometer

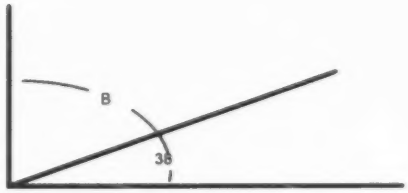
A. _____ B. _____





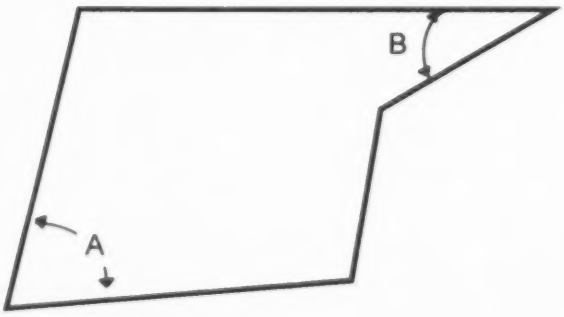
27. Without using a protractor, determine ∠A and ∠B.





28. Using a simple protractor, measure each of the angles, A, B to the nearer degree. It may be necessary to extend sides of angles.

∠A = _____ ∠B = _____



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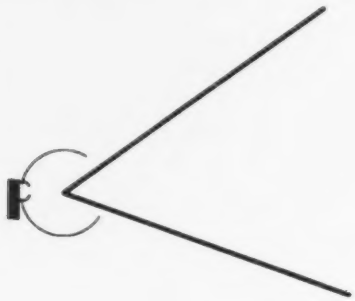
29. Using a protractor measure angle C:



$\angle C$ = _____

30. What is the internal angle if the external angle is 300 ?

_____

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PRETEST ANSWER SHEET

1 A. $\frac{12}{32}$	B. $\frac{16}{64}$	16A. 7.38	B. 50
2A. $\frac{16}{5}$	B. $\frac{23}{4}$	17A. .625	B. $\frac{21}{64}$
3A. $2\frac{1}{2}$	B. $18\frac{3}{4}$	18A. $\frac{15}{32}$	B. $\frac{1}{32}$
4A. $\frac{1}{2}$	B. $\frac{15}{16}$	19A. 6.75 ft.	B. 28.8 ft.
5A. $\frac{1}{16}$	B. .0005	20. left 2 inches	right 1 inch
6A. $\frac{3}{4}$	B. $\frac{33}{32} = 1\frac{1}{32}$	21A. $2\frac{19}{32}$	B. $\frac{19}{64}$
7A. 20	B. $\frac{29}{24} = 1\frac{5}{24}$	22A. 1.719	B. 1.709
8. $2\frac{1}{8}$		23A. $\frac{1}{8}$	B. $\frac{19}{32}$ C. $\frac{3}{8}$
9A. .375	B. 2.063	24A. .12	B. 1.02 C. .6
10A. 6 tenths	B. 147 thousandths	25A. .594	B. 2.094
11A. .3	B. 9.026	26A. .214	B. .334
12A. .60	B. .807	27A. 82	B. 52
13A. .75	B. .667	28A. ~72°	B. ~30°
14A. $2\frac{7}{10}$	B. $\frac{19}{1000}$	29. ~54°	
15A. 23.407	B. .5862	30. 60	

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PRE-BLUEPRINT MATH

Post-test

1. Express each of the following fractions as equivalent fractions as indicated.

$\frac{5}{8} = \frac{\quad}{64}$ $\qquad$ $\frac{7}{16} = \frac{\quad}{64}$

2. Express each of the following mixed numbers as improper fractions.

$2\frac{9}{10} =$ _____ $\qquad$ $13\frac{3}{8} =$ _____

3. Express each of the following improper fractions as mixed numbers.

$\frac{21}{5} =$ _____ $\qquad$ $\frac{115}{32} =$ _____

4. Express each of the following fractions as a fraction in lowest terms.

$\frac{12}{100} =$ _____ $\qquad$ $\frac{18}{64} =$ _____

5. Express the fractions in the following set as equivalent fractions having the least common denominator.

$\frac{7}{16} \quad \frac{5}{32} \quad \frac{9}{64}$ _____

6. Add or subtract each of the following values. Express the answers in lowest terms.

$\frac{7}{16} + \frac{15}{16} =$ _____ $\qquad$ $\frac{49}{64} - \frac{3}{8} =$ _____

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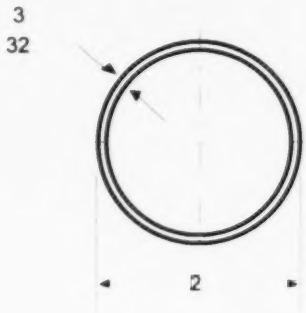
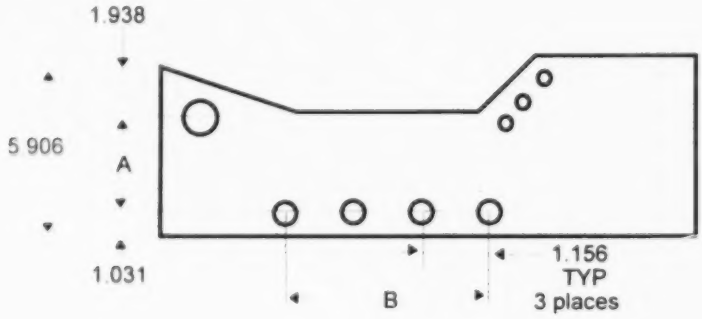
7. Multiply or divide each of the following values. Express the answers in lowest terms.

$\frac{3}{16} \div \frac{2}{5} =$ _____ $16 \times \frac{1}{8} =$ _____

8. Find the inside diameter:



9. Compute dimensions A and B of the support bracket shown. All dimensions are given in inches.



10. Write each of the following numbers as words.

0.74 _____

0.008 _____

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11. Write each of the following numbers to the indicated number of decimal places.

twenty-six hundredths _____

five and eighty-one thousandths _____

12. Round each of the following numbers to the indicated number of decimal places.

5.0467 (hundredths) _____

7.1127 (thousandths) _____

13. Express each of the following common fractions as decimal fractions. Where necessary, round the answers to 3 decimal places.

$\frac{7}{8}$ = _____ $\frac{2}{25}$ = _____

14. Express each of the following decimal fractions as common fractions in lowest terms.

3.05 = _____ .027 = _____

15. Add or subtract each of the following values.

5 + 0.92 + 0.5034 = _____

0.87 - 0.523 = _____

16. Multiply or divide each of the following values. Round the answer to 4 decimal places where necessary.

3.63 x 2.30 = _____

0.85 ÷ 0.39 = _____

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17. Find the decimal or fraction equivalents of each of the following numbers using the decimal equivalent table.

$\frac{17}{32}$ = _____ 0.6563 = _____

18. Determine the nearer fractional equivalents of each of the following decimals using the decimal equivalent table.

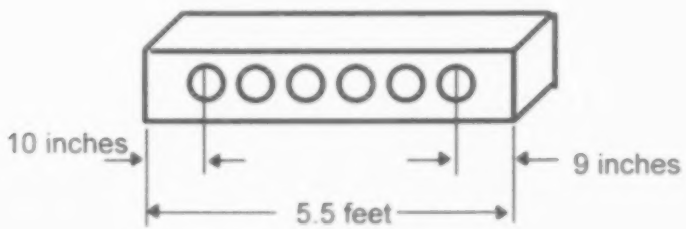
0.769 = _____ 0.961 = _____

19. Express each of the following lengths as indicated.

14 inches as feet _____

$6\frac{1}{4}$ feet as inches _____

20. Holes are to be drilled in the length of angle iron as shown. What is the distance between 2 consecutive holes from center to center? The holes are evenly spaced.



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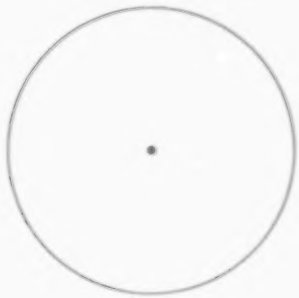
21. Using a steel rule, find the diameter and radius of the circle drawn.

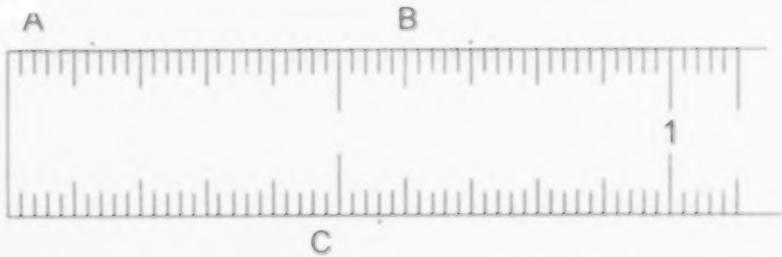


22. The following dimension with tolerance is given. Determine the maximum dimension (upper limit) and the minimum dimension (lower limit).

4.0688" ± 0.0006" = _____ _____

23. Read the measurements A-C on the graduated fractional rule shown.

24. Read the measurements A-C on the graduated rule shown.



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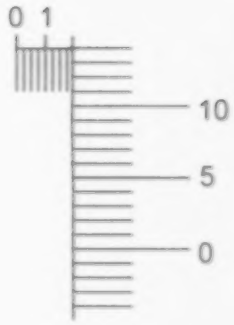
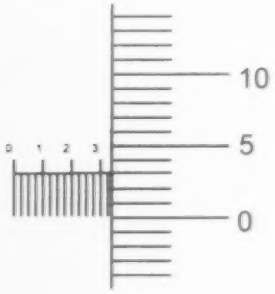
25. Measure the lengths of the following line segments using dial calipers.

26. Read the setting on the following micrometer scales.

0.001 Decimal-Inch Micrometer

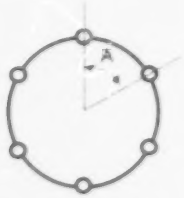
A. = _____ B. = _____





27. Calculate ∠A without measuring it. All the holes are evenly spaced.

∠A = _____



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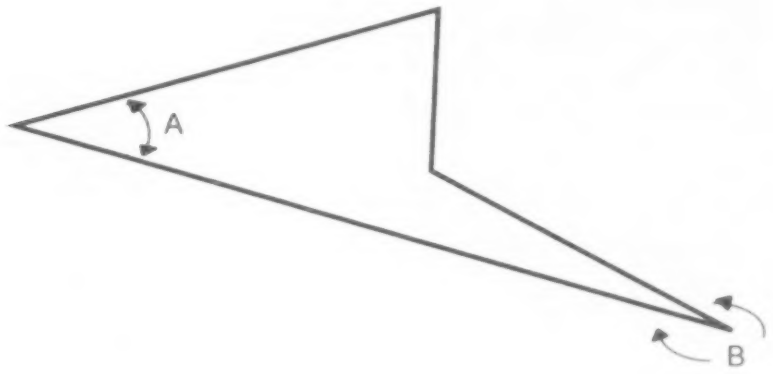
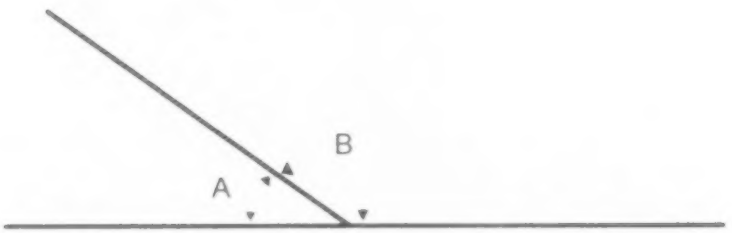
PRE-BLUEPRINT MATH

28. Determine each of the angles, A, B to the nearer degree. Use a protractor where necessary.



∠A = _____ ∠B = _____

29. Using a protractor measure angle A and angle B.



∠A = _____ ∠B = _____

30. What is the internal angle for an external angle of 250° ?

_____

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POST-TEST ANSWER SHEET

1A. 40/64	B. 28/64	16A. 8.349	B. 2.179
2A. 2 9/10	B. 107/8	17A. .5313	B. 21/32
3A. 4 1/5	B. 3 19/32	18A. 49/64	B. 31/32
4A. 3/25	B. 9/32	19A. ' 2"	B. 75 inches
5. 28/64 10/64 9/64		20. 9.4 inches	
6A. 1 3/8	B. 25/64	21A. 1 21/32	B. 53/64
7A. 15/32	B. 2	22A. 4.0694	B. 4.0682
8. 1 13/16		23A. 13/64 B. 1 5/32 C. 5/8	
9A. 2.9375	B. .3853	24A. .13 B. .7 C. .56	
10A. 74 hundredths	B. 8 thousandths	25A. ~ 1.8438	B. ~.8438
11A 26	B. 5.081	26A. .194	B. .328
12A. 5.05	B. 7.113	27. 60°	
13A .875	B. .08	28A. ~ 33°	B. ~347°
14A. 3 1/20	B. 27/1000	29A. ~37°	B. ~145°
15A 6.4234	B. .347	30. 110°	

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